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(54) **Improvements in or relating to relief printing**

(57) A relief printing forme comprises a substrate coated with a composition comprising a polymeric material and a propellant wherein the composition is expanded in selected areas to form a relief printing image. The composition may be applied to the surface of a printing forme cylinder (12) in a printing machine (11) by means of a coating device (18) and then selectively expanded by an imaging device e.g. a laser or heatable pin electrode. Alternatively, an activator or inhibitor may be selectively printed on the composition by ink jet, and the composition heated by an IR heater (19). The composition may be removed after printing by chemical or thermal softening or by embrittlement with dry-ice jets.

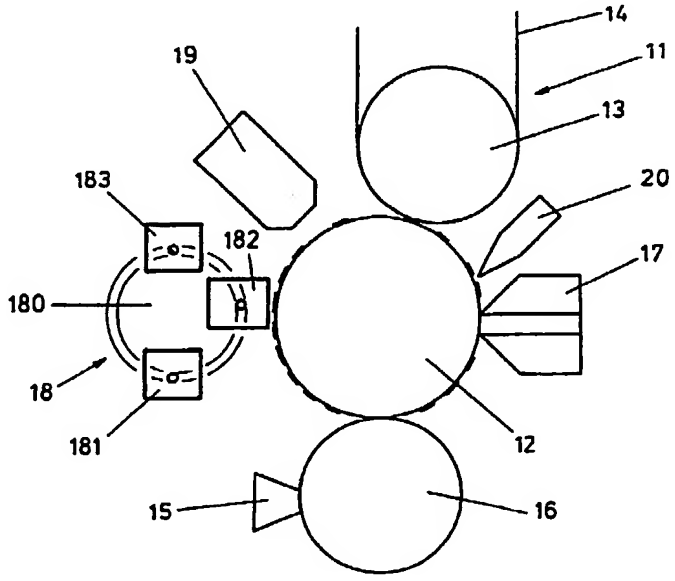

FIG. 5

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

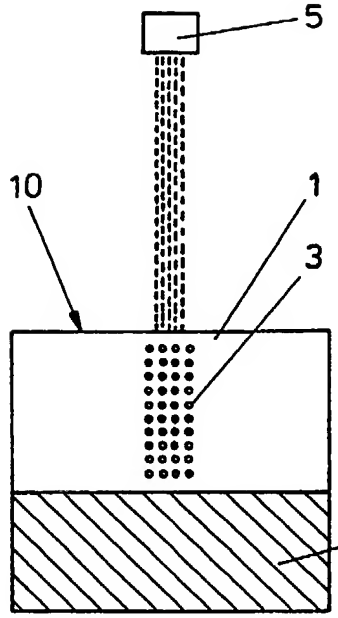

FIG. 1

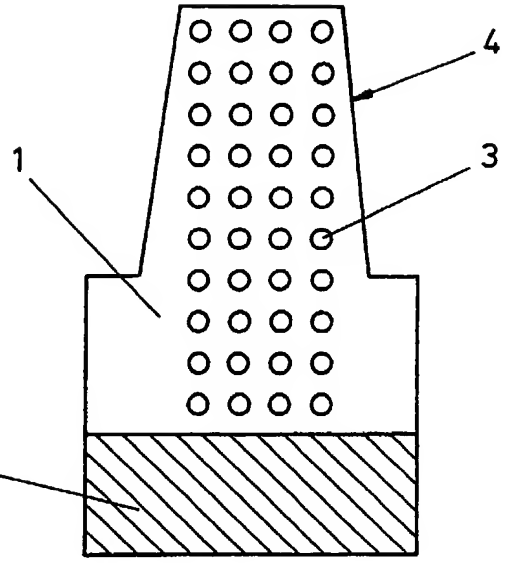

FIG. 2

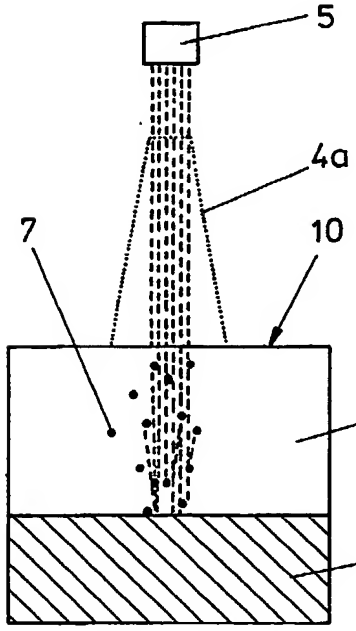

FIG. 3

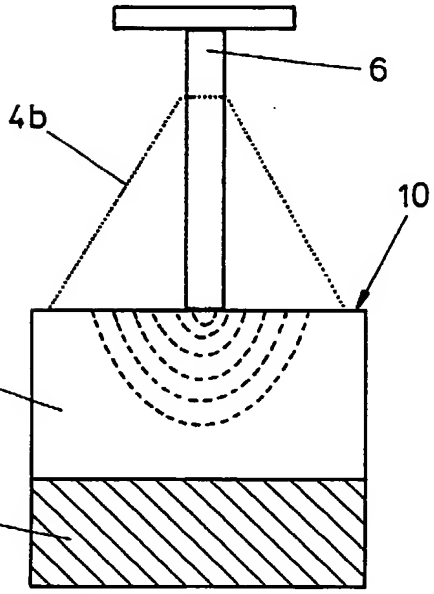

FIG. 4

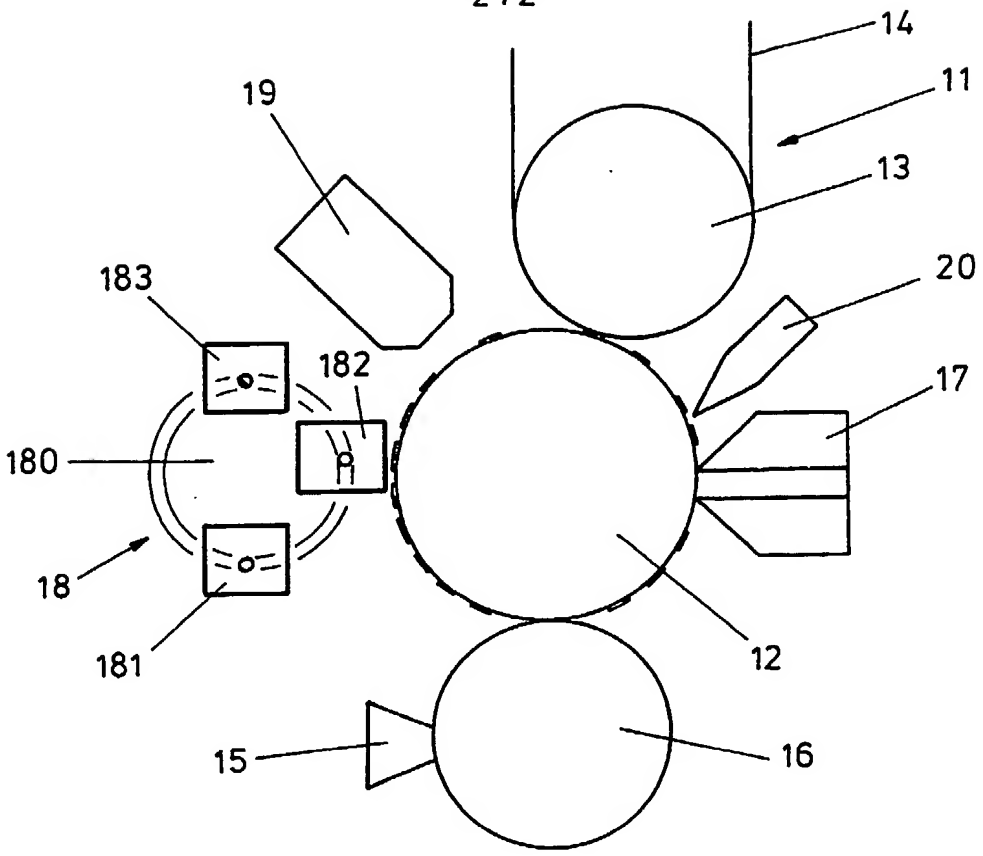

FIG. 5

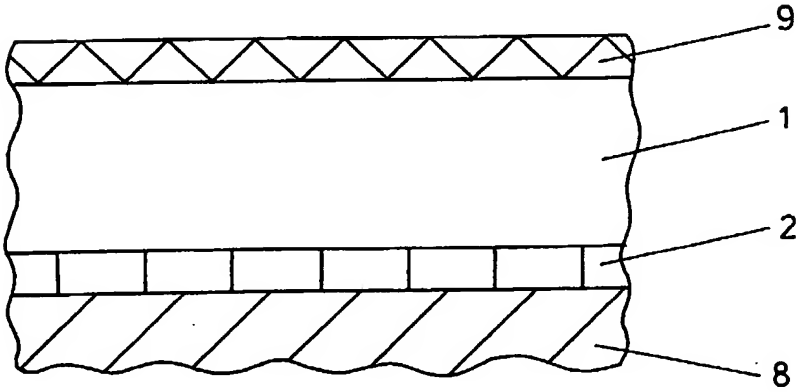

FIG. 6

Improvements in or relating to relief printing

This invention relates to a printing forme for relief printing, in particular for flexographic printing, and to a printing machine including the same.

Also included among relief printing processes is the flexographic printing process in which elastic printing formes, rubber printing plates or photopolymeric printing formes are used. Elastic printing formes makes it possible to print not only on absorbent materials such as paper or card, but also on non-absorbent materials, such as plastics, foils or metal. Flexographic printing formes are also used for in-line lacquering in offset printing machines. Cut-out rubber blankets with recesses are used for surface lacquering whereas these are unsuitable for localised and ornamental lacquering. Thus flexible photopolymeric-flexographic printing plates are used as lacquering plates for the latter.

The conventional technology of flexographic forme production includes the production of rubber plates which in turn are formed from a matrix. In the production of photopolymeric-flexographic printing plates the step of producing the matrix is eliminated; the flexographic printing plates are produced from a precursor by exposure, washing-out of the non-image areas, subsequent drying and subsequent exposure. In addition there are laser-engraved rubber plates. These printing processes are known from "Technik des Flexodrucks", (J. Paris Hrsg.), St Gallen, 1986, 2nd edition).

The conventional methods of production of printing formes for relief printing and in particular for planographic printing are thus based on the fact that the non-printing areas are removed. The processes often require several process steps such as, for

instance, the production of the matrix or several photographic steps, and therefore they are expensive.

Foamable coatings are used in various areas of industry, for instance in the production of textiles, leather, carpets, floor coverings or the like. For instance, DE 19 37 474 discloses a foamable polymer, polyvinyl chloride, in combination with a propellant (azodicarbonamide) and an activator which is suitable for the production of carpeting.

It is the aim of the present invention to provide a novel printing machine including a novel printing forme, formed from this type of foamable material, for relief printing, in particular for the flexographic printing process.

According to one aspect of the present invention there is provided a printing machine including a printing forme cylinder and a means for forming, on the printing forme cylinder, a printing forme comprising a composition including a polymeric material and a propellant wherein the composition is expanded in selected areas to form a relief printing image, said means comprising a coating device including an application unit for applying the composition to the cylinder, an imaging device for expanding selected areas of the composition to form a relief printing image, and an erasing device for removing the composition from the cylinder after printing.

According to another aspect of the present invention there is provided a printing forme precursor for the production of a printing forme for relief printing which precursor comprises a substrate coated with a composition comprising a polymeric material and a propellant capable of expanding the material in selected areas to produce a relief printing image.

A particular advantage of the invention is the fact that the printing forme can be used in a

lacquering unit both for surface lacquering with recesses and also localised and ornamental lacquering.

A printing forme of this type can advantageously be produced inside a printing machine because the forme cylinder does not have to be taken out of it.

For a better understanding of the invention and to show how the same may be carried into effect, reference will now be made, by way of example to the accompanying drawings, in which:-

Figs. 1 to 4 are diagrammatic cross sections through printing formes used in accordance with the invention before and after expansion;

Fig. 5 is a diagrammatic representation of a device for the production and erasure of a printing forme on a forme cylinder; and

Fig. 6 is a diagrammatic cross section through another printing forme of the invention.

In the drawings, like parts are denoted by the same reference numeral.

The printing forme comprises a substrate 8 carrying a layer 1 of a composition comprising a polymeric coating which is capable of expansion in selected areas as desired. The composition is capable of expansion because of the inclusion of an unstable substance 3. These substances decompose with a substantial increase in volume when they are activated physically or chemically or, in particular, physically with chemical assistance. Through image-wise activation and therefore image-wise decomposition of these substances raised areas 4 are produced which form the relief printing image. The activation of the unstable substances, which are called propellants herein, is effected preferably by thermal energy. The image-wise application of thermal energy can be carried out, for instance, by a laser 5 (Fig. 1, Fig. 3) or by a heatable pin electrode 6 (Fig. 4). The lasers used

for image-wise expansion are, for instance, CO_2 lasers or YAG lasers. Because of their focussability the YAG lasers are distinguished by a better resolution. However, they require the addition of particles of carbon black 7 (Fig. 3). The particles of carbon black preferably have a diameter of less than 0.1 µm in order to have optimum dispersability and hence optimum absorption. However, the addition of particles of carbon black 7 can have a disadvantageous effect on the level of expansion which can be attained. Therefore it must be considered whether greater importance is to be attached to the level of expansion or to the resolution of the image to be printed. However, other types of light sources can also be used.

The foamable polymeric material in the layer 1 is, for instance, polyvinyl chloride. Generally a pre-gelled thermal paste of a thermoplastic polymer, is used. The polymeric coatings of the printing formes can be foamed in accordance with an inhibitor process or an activator process, as well as by direct image-wise application of thermal energy and hence image-wise decomposition. In the inhibitor process a kicker as well as a propellant is added to the polymer. According to the printing image to be produced, the layer 1 is printed on its outer surface 10 (Fig. 1) with an inhibitor-containing paste which deactivates the kicker and hence prevents foaming in the areas printed with inhibitor. The image-wise application of the inhibitor-containing paste is effected, for instance, by means of an ink-jet process. Foaming of the coating in the printing image areas is achieved by full-surface (holohedral) heat application, for instance by means of IR radiation. The layer 1 does not foam in the areas printed with the inhibitor as this deactivates the kicker.

In another process the layer 1 is coated image-

wise with an activator. The activator is applied, for instance, by means of the ink-jet process. The pregelled propellant-containing thermoplastic paste forming the layer 1 is thus printed with an activator so that during subsequent full-surface heat application, for instance by means of an IR radiator, it expands more in the printed areas than in the non-printed areas.

As shown in Fig. 6, in order to make the printing forme, produced in accordance with one of the above-described processes, more resistant to mechanical or chemical stresses, for instance to solvents or to abrasion or to the breaking open of pores in the area below the surface 10, a cover layer 9 can be applied above the layer 1 before the layer 1 is foamed by heat. The cover layer 9 preferably contains the same bonding agent system as the layer 1, but in the case of special printing requirements it can also be constructed differently. There may be an adhesive layer 2 between the layer 1 and the substrate 8 to increase the strength of the forme.

The adhesive layer 2, the layer 1 and the cover layer 9 can be applied to the substrate 8 by means of known coating techniques. Particularly suitable is a device comprising a plurality of application units for applying the different layers by means of rollers which are mounted rotatably on a drum which is also rotatable. A coating device of this type can be advantageously arranged inside a printing machine, for instance a web-fed printing machine 11 (Fig. 5). The web-fed printing machine 11 has a printing forme cylinder 12 which is set against an impression cylinder 13 in order to print a web 14 of printing material. Printing ink is applied to the printing forme cylinder 12 by means of a short inking unit (keyless inking system) with a chambered doctor blade 15 and a screen

application roller 16. After the printing forme, formed on the printing forme cylinder 12, has been used and the printing process is over, it can be removed by means of an erasing device 17. There are various possibilities for removing the printing forme, for instance by melting, stripping or embrittlement. Thus, the printing forme coating may first of all be softened thermally or chemically, and then be removed by means of high pressure water jets. Another process consists of embrittling the printing forme coating by cooling and then eroding it mechanically, for instance by CO_2-dry ice jets, i.e. by bombarding it with dry ice pellets.

If the printing forme to be newly produced is to comprise the adhesive layer 2, the layer 1 and the cover layer 9 it is necessary to have a coating device 18 having three application units 181, 182, 183. Each of the individual application units 181 to 183 is preferably constructed as a rotatable roller dipping into a container filled with the material of the layer to be applied and which can be set onto the respective surface of the printing forme cylinder 12 in order to coat it with the respective material. Each of the application units 181 to 183 is in turn arranged on a rotatable drum 180 so that by rotating the drum 180 the application units 181 to 183 can be set one after the other against the surface of the printing forme cylinder 12. The respectively applied layer can be dried by means of a dryer 19, e.g. an IR heat source. An imaging device is included to expand selected areas of layer 1 to from the relief printing image. For example, by providing an ink jet application device as well as the application units 181 to 183, activator or an inhibitor may be selectively applied to the outer surface of the layer 1 so that selected areas are

subsequently foamed by the dryer 19 to form the relief printing image. Instead of foaming the layer 1 in accordance with the inhibitor or the activator process it can be foamed in the desired printing areas also by means of an imaging device in the form of a laser 20.

The application thickness of the foamable paste material is dependent on the desired expansion of the coating. The coating expansion has to correspond to a relief depth of at least 0.39 mm to 3.5 mm at the most, which is normal in flexographic printing. In order to print smooth surfaces relief depths of 0.39 to 1.10 mm are usual, and with very uneven printing materials, such as corrugated card, relief depths of 3.0 to 3.5 mm are usual. Commercially available propellants have minimum grain sizes of about 10 µm and expansion factors of 20 to 200 ml/g. So a coating expansion of about three to six times the application thickness of the pre-dried foamable material is possible. In order to achieve the level differences between the printing and non-printing areas of the outer surface 10 of the layer 1 of about 0.8 mm, usual in flexographic printing, an application thickness of the pre-dried foamable material of 200 µm on average is necessary.

To produce the layer 1 the coating contains one or several polymeric film formers as its main components, and these are expanded by the addition of suitable propellants. The material properties of the film formers and propellants have to be carefully selected in order to make possible the greatest possible and most uniform expansion of the propellant and hence of the coating. For the coating, thermoplastics such as poly vinyl chloride, polyolefins, ethylene-vinyl-acetate-copolymers, polystyrene, polyamide, acrylo nitrile-butadiene-styrene-copolymers, or thermoplastic elastomers (plastics) or elastomers (rubber) may be used. Apart from the desired good imaging and printing

properties these polymer groups also have the property of being easily deleted by melting, stripping or embrittlement by means of the erasing device 17.

Propellants are added to these coating materials, their amount being selected in such a way that on activation there is an expansion of the coating to a uniform predetermined printing forme level usual in flexographic printing. The propellant distribution and particle size are important considerations in the production of finely-structured printing images with optimum stability of the expanded areas. The smaller the gas bubbles in the coating, the narrower and hence more stable is the bonding agent grid. The distribution of the propellant therefore has to be very uniform, and preferably very fine-particled propellants with a particle diameter of between 5 and 10 µm are used.

Solid chemical propellants are particularly suitable. Azodicarbonamide, azo-isobutyro-dinitrile, toluol sulphohydrazide and 4,4'-oxy-bis-benzol sulphohydrazide are suitable, for example. Organic propellants based on hydrazides and azo compounds are exothermic.

Inorganic propellants such as sodium hydrogen carbonate or ammonium carbonate in combination with weak organic acids such as, for example, citric acid, react endothermically. Therefore the exothermic organic propellants are particularly suitable for the present invention. The propellant content in the coating material is preferably between 1 and 25%.

In the case of the activator process an activator (kicker) is additionally added to the coating material. Lead-, zinc- and cadmium-compounds such as PbO, ZnO, CdO, cadmium acetate and/or isophorondiamine and/or dodecyl amine are suitable for this; normally 0.5 to 5% stabiliser is added.

In the inhibitor process inhibitors such as fumaric acid, maleic acid, oxalic acid, hydroquinone, thiourea, trimellitic acid-anhydride or methyl-ethyl-ketone in conjunction with azodicarbonamide may be used. The use of substances of this type is known, for instance, from DE 19 37 474, GB 2 076 005 or DE 30 43 202.

In addition other additives can be added to the coating material. For instance carbon black increases the laser sensitivity because it absorbs the laser light very well within a wide wavelength range. The carbon black content may vary within a range of from 0.1 to 10% according to the type of laser used. The wavelength absorption in the coating material and hence the decomposition of the propellant can be precisely controlled by the introduction of carbon black. As shown by a comparison of the laser source 5 in Fig. 3 and the pin electrode 6 in Fig. 4, a much steeper relief 4a can be obtained for the printing image when there is excitation with laser light than relief 4b when there is heating by the pin electrode 6. In the latter case the heat acts on the surface of the layer and hence there is uniform heat dispersion in all directions by heat conduction in the layer 1. With the laser 5 the thermal excitation acts in the entire irradiated range at the same time, provided that the distribution and concentration of the absorber material such as, for instance, carbon black particles, are optimal. Propellant activation by heat conduction is minimised in the case of laser exposure. Because of this, steeper relief edges 4a and more uniform pore sizes are produced from the propellant. This in turn leads to advantageous properties of the expanded coating with respect to stability and resolution.

In addition the layer 1 can also contain other inorganic fillers which increase the mechanical

stability of the porous expanded regions. In order to improve the ink-receiving behaviour, materials can be added which improve the surface properties of the printing forme.

A printing forme produced according to this principle can be used for other relief printing processes instead of for the flexographic printing process, if coating materials with the respectively necessary hardness are used.

According to the invention a foamable material which contains a polymer paste and a propellant and which is contained in a layer 1, or at least a layer 1 in a series of superposed layers 9, 1, 2, is used for the production of a printing forme for a printing process, in particular for the flexographic printing process, by expanding the material in the printing areas. The process may be carried out preferably inside a printing machine 11 by means of a coating device 18 which has several application units 181 to 183. The printing forme thus produced on the surface of the printing forme cylinder 12 can be expanded by foaming, for instance by means of a laser 20, according to the image to be printed by the printing image. The used printing forme can be removed again by erasing device 17 when the printing process is over.

The printing forme which can be produced and erased in accordance with the invention can also be used in particular on a printing forme cylinder 12 of a lacquering unit which is constructed like the device shown in Fig. 5. The last printing unit of a printing machine for the direct or indirect printing of a web- or sheet-like printing material is used as the lacquering unit.

From DE 39 06 648 A1 there is known a lacquering unit having a printing forme cylinder for recessed lacquering with which only specific surface portions of

a material, e.g. in the case of folding boxes, are lacquered.

The lacquering unit of the invention as shown in Fig. 5, and having the coating device 18, the erasing device 17, and the laser 20 for imaging, is suitable for producing surface varnishing with recesses as well as localised and decorative varnishing.

Claims

1. A device including a printing forme cylinder and a means for forming, on the printing forme cylinder, a printing forme comprising a composition including a polymeric material and a propellant wherein the composition is expanded in selected areas to form a relief printing image, said means comprising a coating device including an application unit for applying the composition to the cylinder, an imaging device for expanding selected areas of the composition to form a relief printing image, and an erasing device for removing the composition from the cylinder after printing.

2. A device as claimed in claim 1 wherein the imaging device includes a heating means to expand said selected areas of the composition.

3. A device as claimed in claim 1 or 2 wherein the heating means is a heatable pin electrode or a laser.

4. A device as claimed in any one of claims 1, 2 and 3 wherein the coating device includes at least one additional application unit for applying one or more additional layers to the cylinder.

5. A device as claimed in claim 1 substantially hereinbefore described with reference to and as illustrated in Fig. 5 of the accompanying drawings.

6. The use of a device as claimed in any one of claims 1 to 5 for surface lacquering or localised and ornamental lacquering.

7. A device having an erasable letterpress printing forme, in particular a flexographic printing forme, on a printing forme cylinder, in particular inside a printing machine, having a coating device, an imaging device and an erasing device, whereby a foamable composition can be applied with the coating device, this composition containing a polymer paste and

a propellant and being contained in a layer or in at least one layer of a series of superposed layers, and areas of the composition can be expanded to form a printing image.

8. A device according to claim 7, wherein it has heating means to expand the composition in said areas.

9. A device according to claim 8, wherein the heating means includes a heatable pin electrode or a laser, in particular a YAG- or a CO_2 laser, by means of which the composition can be expanded, the composition containing in particular an absorber material, in particular carbon black.

10. A device according to one of claims 7 to 9, wherein the coating device includes several application units for applying coatings to the printing forme cylinder, these application units being rotatable on a drum.

11. A device according to any preceding claim wherein the non-image areas of the composition are treated with an inhibitor, in particular by means of an ink jet process, and the whole of the outer surface of the composition is heated, in particular by IR-radiation, to expand the composition in the areas not treated with the inhibitor.

12. A device according to any one of claims 1 to 10, wherein the image areas of the composition are treated with an activator, in particular by means of an ink jet process, and the whole of the outer surface of the composition is heated, in particular by IR-radiation, to expand the composition in the areas treated with the activator.

13. A device according to any one of claims 1 to 12, wherein the composition comprises a thermoplast, such as polyvinyl chloride, a polyolefin, an ethylene-vinyl acetate-copolymer, polystyrene, a polyamide, an acrylonitrile-butadiene-styrene copolymer; or a

thermoplastic elastomer (plastics); or an elastomer (rubber).

14. A device according to any one of claims 1 to 13, wherein the propellant is an organic propellant such as azodicarbonamide, azoisobutyro-dinitrile, toluo-sulphohydrazide or 4,4'-oxy-bis-benzo sulphohydrazide or an inorganic propellant such as sodium hydrogen carbonate or ammonium carbonate in combination with a weak organic acid, in particular citric acid.

15. A device according to claim 11, wherein the composition is treated with fumaric acid, maleic acid, oxalic acid, hydroquinone, thiourea, trimellitic acid-anhydride or methyl-ethyl ketone as the inhibitor.

16. A device according to claim 12, wherein the composition is treated with a lead-, zinc- or cadmium compound such as lead oxide, zinc oxide, cadmium oxide or cadmium acetate and/or isophorone diamine and/or dodecylamine as the activator.

Patents Act 1977 **Examiner's report to the Comptroller under Section 17** **(e Search report)**	Application number GB 9424815.0
Relevant Technical Fields (i) UK Cl (Ed.N) B6C: CBAR, CHD, CHF G2C: CC13 (ii) Int Cl (Ed.6) B41C: 1/00, 1/05, 1/055	Search Examiner A DAVEY Date of completion of Search 1 FEBRUARY 1995
Databases (see below) (i) UK Patent Office collections of GB, EP, WO and US patent specifications. (ii) ONLINE DATABASE: WPI	Documents considered relevant following a search in respect of Claims :- 1 TO 16

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E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

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Category	Identity of document and relevant passages		Relevant to claim(s)
A	GB 1402043 A	(MINNESOTA)	
A	EP 0432506 A	(MAN ROLAND)	
A	US 3654864	(ENERGY CONVERSION)	

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